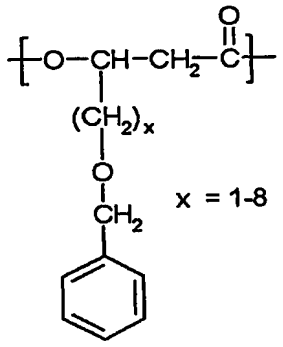
CLAIMS

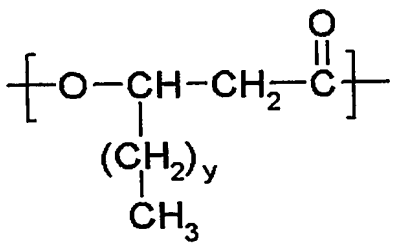
1. A polyhydroxyalkanoate comprising a 3-hydroxy-ω-[(phenylmethyl)oxy]alkanoic acid unit expressed by chemical formula (1):



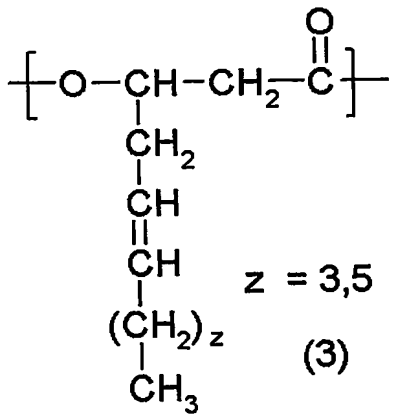
(1)

wherein x can be one or more integers within the range shown in the chemical formula.

2. The polyhydroxyalkanoate according to claim 1, comprising at least one unit expressed by chemical formula selected from the group consisting of chemical formulas (2) and (3):



(2)

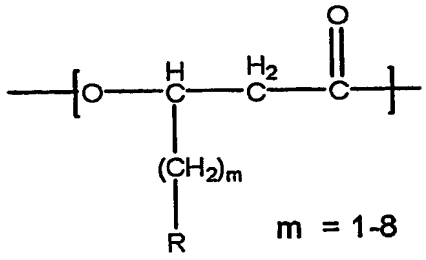


(3)

wherein y and z can be one or more integers within

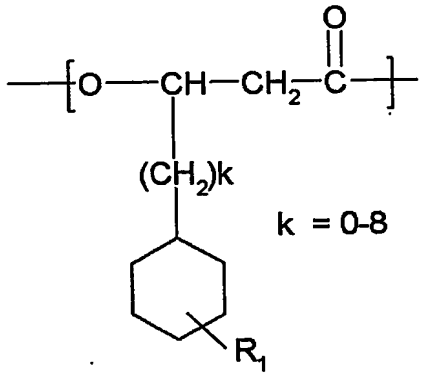
the range shown in the chemical formulas, while being independent from the unit expressed by chemical formula (1).

3. The polyhydroxyalkanoate according to claim 1, comprising, in a molecule thereof, the 3-hydroxy-ω-[(phenylmethyl)oxy]alkanoic acid unit expressed by chemical formula (1) and a 3-hydroxy-alkanoic acid unit expressed by chemical formula (4):



(4)

wherein m can be one or more integers within the range shown in the chemical formula, and R comprises a residue having either a phenyl structure or thienyl structure, or a 3-hydroxy-ω-cyclohexylalkanoic acid unit expressed by chemical formula (5):



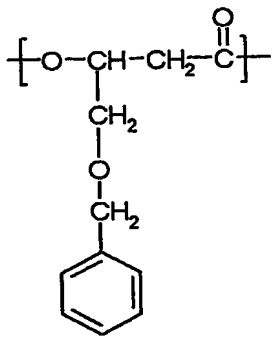
(5)

wherein R_1 is H, CN, NO_2, halogen, CH_3, C_2H_5, C_3H_7, CF_3, C_2F_5 and C_3F_7, and k can be one or more integers

within the range shown in the chemical formula.

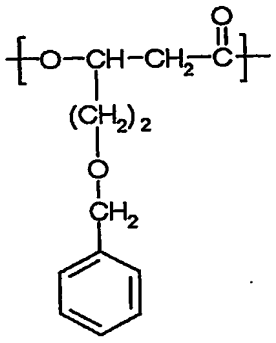
4. The polyhydroxyalkanoate according to claim 1, wherein the 3-hydroxy-ω-[(phenylmethyl)oxy]alkanoic acid unit expressed by chemical formula (1) is either one or both of:

a 3-hydroxy-4-[(phenylmethyl)oxy]butyric acid unit expressed by chemical formula (6):



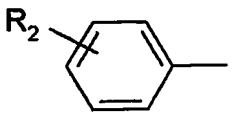
(6)

and a 3-hydroxy-5-[(phenylmethyl)oxy]valeric acid unit expressed by chemical formula (7):



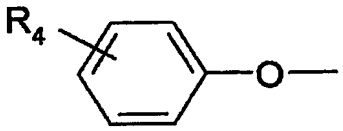
(7)

5. The polyhydroxyalkanoate according to claim 3, wherein R in chemical formula (4) is a group selected from the group consisting of



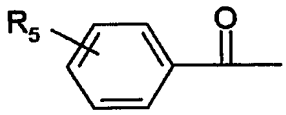
(8)

wherein R_2 is H, halogen, CN, NO_2, CH_3, C_2H_5, C_3H_7, $CH=CH_2$, $COOR_3$ (wherein R_3 represents any one selected from the group consisting of H, Na and K), CF_3 , C_2F_5 and C_3F_7 , and in a case where there exist a plurality of units, R_2 may be different for each unit;



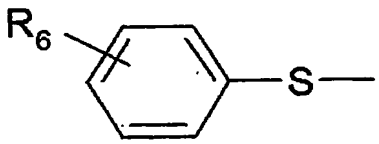
(9)

wherein R_4 is selected from the group consisting of H, halogen, CN, NO_2, CH_3, C_2H_5, C_3H_7, SCH_3, CF_3, C_2F_5 and C_3F_7, and in a case where there exist a plurality of units, R_4 may be different for each unit;



(10)

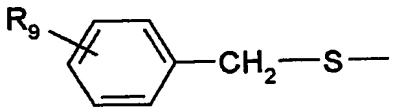
wherein R_5 is selected from the group consisting of H, halogen, CN, NO_2, CH_3, C_2H_5, C_3H_7, CF_3, C_2F_5 and C_3F_7, and in a case where there exist a plurality of units, R_5 may be different for each unit;



(11)

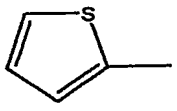
wherein R_6 is selected from the group consisting of H, halogen, CN, NO_2, $COOR_7$, SO_2R_8 (wherein R_7 represents

any one selected from the group consisting of H, Na, K, CH_3 and C_2H_5, and R_8 represents any one selected from the group consisting of OH, ONa, OK, halogen, OCH_3 and OC_2H_5), CH_3, C_2H_5, C_3H_7, $(CH_3)_2$-CH, and $(CH_3)_3$-C , and in a case where there exist a plurality of units, R_6 may be different for each unit;

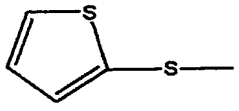


(12)

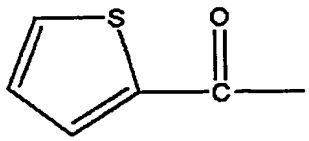
wherein R_9 represents a substituent group on the aromatic ring, R_9 is selected from thg group consisting of H, halogen, CN , NO_2 , $COOR_{10}$, SO_2R_{11} (wherein R_{10} represents any one selected from the group consisting of H, Na, K, CH_3 and C_2H_5, and R_{11} represents any one selected from the group consisting of OH, ONa, OK, halogen, OCH_3 and OC_2H_5), CH_3, C_2H_5, C_3H_7, $(CH_3)_2$-CH and $(CH_3)_3$-C, and in a case where there exist a plurality of units, R_9 may be different for each unit;



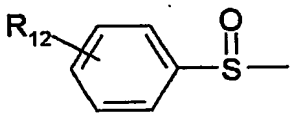
(13)



(14)

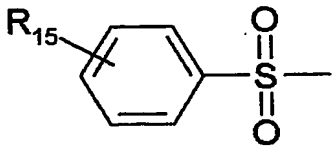


(15)



(16)

wherein R_{12} is selected from thg group consisting of H, halogen, CN, NO_2, $COOR_{13}$, SO_2R_{14} (wherein R_{13} represents any one selected from the group consisting of H, Na, K, CH_3 and C_2H_5, and R_{14} represents any one selected from the group consisting of OH, ONa, OK, halogen, OCH_3 and OC_2H_5), CH_3, C_2H_5, C_3H_7, $(CH_3)_2$-CH and $(CH_3)_3$-C, and in a case where there exist a plurality of units, R_{12} may be different for each unit; and



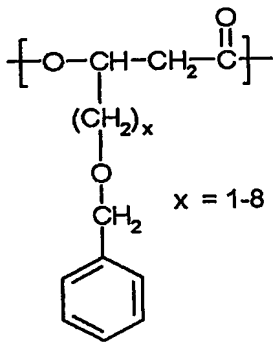
(17)

wherein R_{15} is selected from the group consisting of H, halogen, CN, NO_2, $COOR_{16}$, SO_2R_{17} (wherein R_{16} represents any one selected from the group consisting of H, Na, K, CH_3 and C_2H_5, and R_{17} represents any one selected from the group consisting of OH, ONa, OK, halogen, OCH_3 and OC_2H_5), CH_3, C_2H_5, C_3H_7, $(CH_3)_2$-CH and $(CH_3)_3$-C, and in a case where there exist a plurality of units, R_{15} may be different for each unit.

6. The polyhydroxyalkanoate according to claim 1,

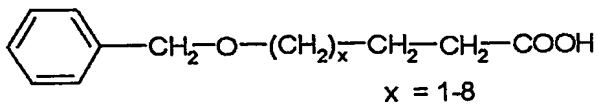
wherein a number average molecular weight is within the range between 1,000 and 1,000,000.

7. A method for producing a polyhydroxyalkanoate comprising, in a molecule thereof, a 3-hydroxy-ω-[(phenylmethyl)oxy]alkanoic acid unit expressed by chemical formula (1):



(1)

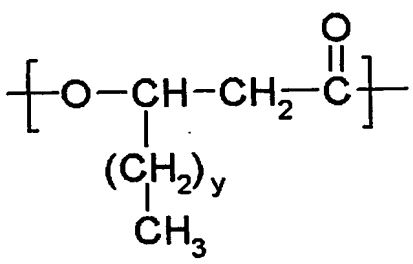
wherein x can be one or more integers within the range shown in the chemical formula, which comprises allowing a microorganism with an ability to produce a polyhydroxyalkanoate comprising in a molecule thereof a 3-hydroxy-ω-[(phenylmethyl)oxy]alkanoic acid unit expressed by chemical formula (1) to biosynthesize the polyhydroxyalkanoate under a condition which comprise ω-[(phenylmethyl)oxy]alkanoic acid expressed by chemical formula (19):



(19)

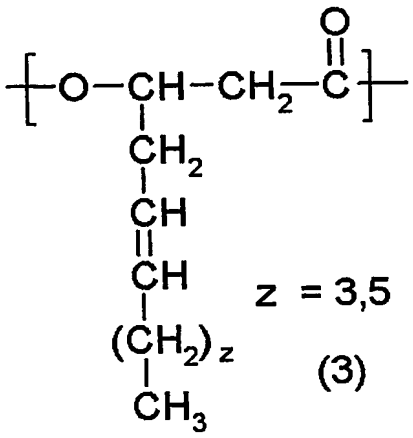
wherein x can be one or more integers within the range shown in the chemical formula.

8. The method for producing a polyhydroxyalkanoate according to claim 7, wherein the polyhydroxyalkanoate comprises at least one unit expressed by the following chemical formulas (2) and (3):



y = 1-8

(2)

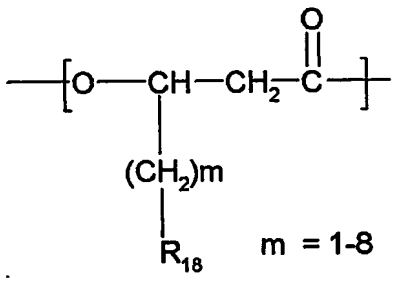


z = 3,5

(3)

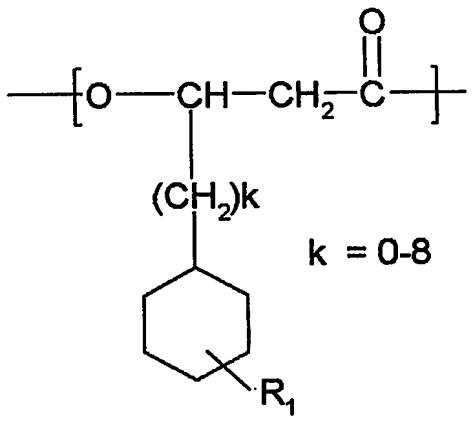
wherein y and z can be one or more integers within the range shown in the chemical formulas, while being independent from the unit expressed by chemical formula (1).

9. The method for producing a polyhydroxyalkanoate according to claim 7, comprising allowing the microorganism with an ability to produce a polyhydroxyalkanoate comprising, in a molecule thereof, the 3-hydroxy-ω-[(phenylmethyl)oxy]alkanoic acid unit expressed by chemical formula (1) and a 3-hydroxy-alkanoic acid unit expressed by chemical formula (22):



(22)

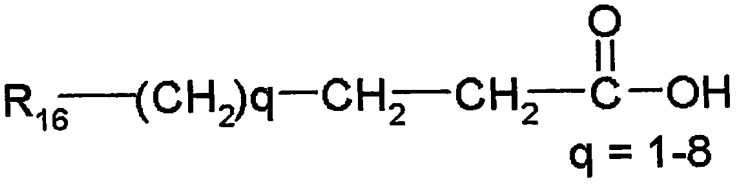
wherein m can be one or more integers within the range shown in the chemical formula, and R_{18} comprises a residue having either a phenyl structure or thienyl structure, or 3-hydroxy-ω-cyclohexylalkanoic acid unit expressed by chemical formula (5):



(5)

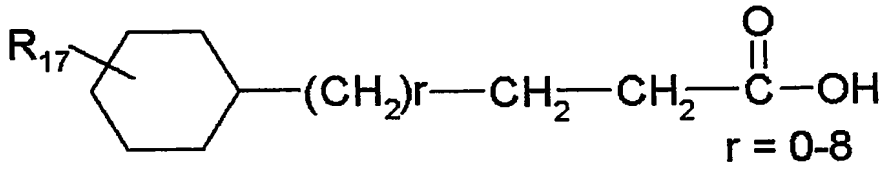
wherein R_1 is selected from the group consisting of H, CN, NO_2, halogen, CH_3, C_2H_5, C_3H_7, CF_3, C_2F_5 and C_3F_7, and k can be one or more integers within the range shown in the chemical formula,

from ω-[(phenylmethyl)oxy]alkanoic acid expressed by chemical formula (19), and a alkanoic acid expressed by chemical formula (20):



(20)

wherein q can be one or more integers within the range shown in the chemical formula, and R_{16} comprises a residue having either a phenyl structure or thienyl structure, or ω-cyclohexylalkanoic acid expressed by chemical formula (21) :

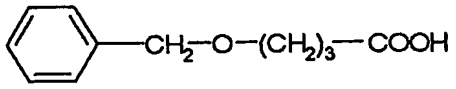


(21)

wherein R_{17} is selected from the group consisting of H, CN, NO_2, halogen, CH_3, C_2H_5, C_3H_7, CF_3, C_2F_5 and C_3F_7, and r can be one or more integers within the range shown in the chemical formula as raw materials to biosynthesize the polyhydroxyalkanoate under a condition which comprise ω-[(phenylmethyl)oxy]alkanoic acid expressed by chemical formula (19), and alkanoic acid expressed by chemical formula (20) or ω-cyclohexylalkanoic acid expressed by chemical formula (21).

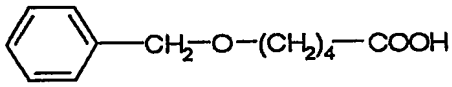
10. The method for producing a polyhydroxyalkanoate according to claim 7, wherein the ω-[(phenylmethyl)oxy]alkanoic acid expressed by said chemical formula (19) is 4-[(phenylmethyl)oxy]butyric

acid expressed by chemical formula (23):



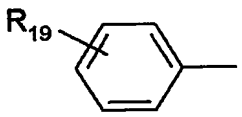
(23)

or 5-[(phenylmethyl)oxy]valeric acid expressed by chemical formula (24):



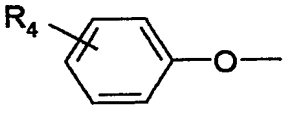
(24).

11. The method for producing a polyhydroxyalkanoate according to claim 9, wherein R_{16} in chemical formula (20) and R_{18} in chemical formula (22) are groups independently selected from the group consisting of



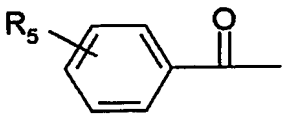
(25)

wherein R_{19} is selected from the group consisting of H, halogen, CN, NO_2, CH_3, C_2H_5, C_3H_7, $CH=CH_2$, CF_3, C_2F_5 and C_3F_7, and in a case where there exist a plurality of units, R_{19} may be different for each unit;



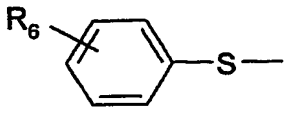
(9)

wherein R_4 is selected from the group consisting of H, halogen, CN, NO_2, CH_3, C_2H_5, C_3H_7, SCH_3, CF_3, C_2F_5 and C_3F_7, and in a case where there exist a plurality of units, R_4 may be different for each unit;



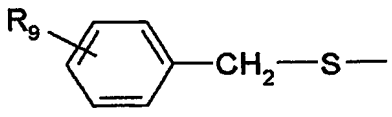
(10)

wherein R_5 is selected from the group consisting of H, halogen, CN, NO_2, CH_3, C_2H_5, C_3H_7, CF_3, C_2F_5 and C_3F_7, and in a case where there exist a plurality of units, R_5 may be different for each unit;



(11)

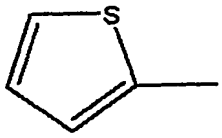
wherein R_6 is selected from the group consisting of H, halogen, CN, NO_2, $COOR_7$, SO_2R_8 (wherein R_7 represents any one selected from the group consisting of H, Na, K, CH_3 and C_2H_5, and R_8 represents any one selected from the group consisting of OH, ONa, OK, halogen, OCH_3 and OC_2H_5), CH_3, C_2H_5, C_3H_7, $(CH_3)_2$-CH and $(CH_3)_3$-C, and in a case where there exist a plurality of units, R_6 may be different for each unit;



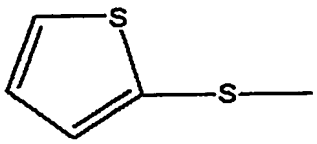
(12)

wherein R_9 is selected from the group consisting of H, halogen, CN, NO_2, $COOR_{10}$, SO_2R_{11} (wherein R_{10} represents any one selected from the group consisting of H, Na, K, CH_3 and C_2H_5, and R_{11} represents any one selected from the group consisting of OH, ONa, OK, halogen, OCH_3 and OC_2H_5), CH_3, C_2H_5, C_3H_7, $(CH_3)_2$-CH and $(CH_3)_3$-C,

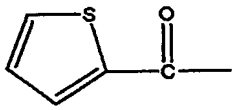
and in a case where there exist a plurality of units, R_9 may be different for each unit;



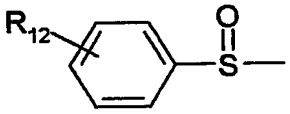
(13)



(14)

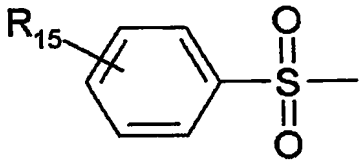


(15)



(16)

wherein R_{12} is selected from the group consisting of H, halogen, CN, NO_2, $COOR_{13}$, SO_2R_{14} (wherein R_{13} represents any one selected from the group consisting of H, Na, K, CH_3 and C_2H_5, and R_{14} represents any one selected from the group consisting of OH, ONa, OK, halogen, OCH_3 and OC_2H_5), CH_3, C_2H_5, C_3H_7, $(CH_3)_2$-CH and $(CH_3)_3$-C, and in a case where there exist a plurality of units, R_{12} may be different for each unit; and



(17)

wherein R_{15} is selected from the group consisting of H, halogen, CN, NO_2, $COOR_{16}$, SO_2R_{17} (wherein R_{16} represents any one selected from the group consisting of H, Na, K, CH_3 and C_2H_5, and R_{17} represents any one selected from the group consisting of OH, ONa, OK, halogen, OCH_3 and OC_2H_5), CH_3 , C_2H_5, C_3H_7, $(CH_3)_2$-CH and $(CH_3)_3$-C, and in a case where there exist a plurality of units, R_{15} may be different for each unit.

12. The method for producing a polyhydroxyalkanoate according to claim 7, wherein said condition is that said microorganisms is cultured in a medium containing ω-[(phenylmethyl)oxy]alkanoic acid expressed by chemical formula (19).

13. The method for producing a polyhydroxyalkanoate according to claim 9, wherein said condition is that said microorganism is cultured in a medium containing the ω-[(phenylmethyl)oxy]alkanoic acid expressed by chemical formula (19) and the alkanoic acid expressed by chemical formula (20) or the ω-cyclohexylalkanoic acid expressed by chemical formula (21).

14. The method for producing a polyhydroxyalkanoate according to claim 12, wherein said medium contains at least one selected from the group consisting of

peptides, yeast extract, organic acids or salts thereof, amino acids or salts thereof, saccharides and straight-chain alkanoic acids , which is saturated or unsaturated fatty acid having 4 to 12 carbon atoms or salts thereof.

15. The method for producing a polyhydroxyalkanoate according to claim 14, wherein the peptide is polypeptone; the organic acids or salts thereof are one or more compounds selected from the group consisting of pyruvic acid, oxaloacetic acid, citric acid, isocitric acid, ketoglutaric acid, succinic acid, fumaric acid, malic acid, lactic acid, and salts thereof; the amino acids or salts thereof are one or more compounds selected from the group consisting of glutamic acid, aspartic acid, and salts thereof; and the saccharides are one or more compounds selected from the group consisting of glyceroaldehyde, erythrose, arabinose, xylose, glucose, galactose, mannose, fructose, glycerol, erythritol, xylitol, gluconic acid, glucuronic acid and galacturonic acid, maltose, sucrose and lactose.

16. The method for producing a polyhydroxyalkanoate according to claim 12, wherein said culture of microorganisms comprises two or more culturing steps.

17. The method for producing a polyhydroxyalkanoate according to claim 16, wherein said culture is a fed-batch culture.

18. The method for producing a polyhydroxyalkanoate according to any one of claims 12 to 17, comprising a step of recovering a polyhydroxyalkanoate comprising 3-hydroxy-ω-[(phenylmethyl)oxy]alkanoic acid unit expressed by chemical formula (1) generated by the microorganism from the cells of the microorganism.

19. The method for producing a polyhydroxyalkanoate according to claim 7, wherein said microorganism belongs to Pseudomonas species.

20. The method for producing a polyhydroxyalkanoate according to claim 19, wherein said microorganism is one or more strains selected from the group consisting of Pseudomonas cichorii YN2 (FERM BP-7375), Pseudomonas cichorii H45 (FERM BP-7374) and Pseudomonas jessenii P161 (FERM BP-7376).